Carbon Dioxide Emissions and Economic Growth: An Assessment Based on Production and Consumption Emission Inventories

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1. Introduction

The relationship between emissions and economic growth is at the centre of debate on the appropriate policies for targeting greenhouse gas emissions. The need for urgent action regarding climate change has been emphasised in the formulation of the UN’s sustainable development goals (SDGs), while the Paris climate conference (COP21, December 2015) stressed the importance of broadening the geographic scope of action. The Paris Agreement was finally adopted by 195 developed and developing countries. In this regard, expanding production and consumption in emerging economies pose challenges not just to emissions targets themselves, but also to the cross-country fairness of effective policy instruments. The deepening of cross-border trade and production linkages weakens the links between national commitments on emissions and the actual incentives to control emissions globally and further complicates the policy challenge.1

Against this backdrop it is important to understand the connections between emissions and future economic growth. A substantial literature emphasises a linkage between national income levels and

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demand for greater environmental quality at local level—generally known as the environmental Kuznets curve (EKC) hypothesis. The EKC hypothesis postulates that pollution increases with economic growth in the early stages of development but decreases again after a certain level of development has been reached. The point beyond which economic growth is associated with reduced pollution depends on several factors such as greater willingness to pay for environmental quality at higher levels of income. However, the political economy factors driving a local EKC (such as voters demanding cleaner water and air) may not extend from local pollutants to global ones such as CO$_2$, since they show potential for externalisation due to global mixing of greenhouse gases and are regarded as a necessary cost of economic growth.\(^5\) In addition, with outsourcing and global production networks, national targets, for example for industry based in Germany, fail to take account of CO$_2$ produced in one location, for example China, and consumed in Germany. Hence, while the treaty framework first developed to address emission levels, in particular the Kyoto Protocol, rests on commitments on emissions within national boundaries, the connection between local activity and global emissions has been weakened by the emergence of regional and global production networks (aka global value chains).

In this paper, we focus on the extent to which we can expect global patterns of production and consumption to become more (or less) environmentally sustainable as more low- and middle-income countries converge to the production and consumption patterns of higher income countries. Working with data that reflect cross border production linkages, we investigate the relationship between CO$_2$ emissions intensity per unit of output may decline with per capita income, the volume effects of greater production/consumption far outweigh any tendency to falling CO$_2$ intensity per additional dollar of income. Globally, with rising incomes, we can expect rising CO$_2$ levels embodied in both production and consumption. Our findings highlight the need for a more comprehensive framework of policy instruments that target emissions embodied in final consumption and not just the geography of production so that carbon efficiency gains can spread across supply chains and levels of development.

Our results indicate that income-driven shifts in consumption are more carbon intensive than those associated with production, with the difference being of economic significance. Still, both income-elasticities are smaller than one, showing relative decoupling between carbon emissions and economic growth. Income elasticities associated with both inventories tend to slightly decrease after a certain level of development has been reached, showing small carbon efficiency gains from development. On net, while emissions intensity per unit of output may decline with per capita income, the volume effects of greater production/consumption far outweigh any tendency to falling CO$_2$ intensity per additional dollar of income. Globally, with rising incomes, we can expect rising CO$_2$ levels embodied in both production and consumption. Our findings highlight the need for a more comprehensive framework of policy instruments that target emissions embodied in final consumption and not just the geography of production so that carbon efficiency gains can spread across supply chains and levels of development.

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2 The empirical evidence for the existence of an inverted-U relationship between CO$_2$ emissions and economic development is rather weak and restricted to developed economies. Indeed, it suggests that CO$_2$ emissions per capita may increase as income per capita rises (see, e.g., Dasgupta et al., 2002 and Stern, 2004 and 2015). Although Aichele and Felbermayr (2012) estimate the impact of the ratification of the Kyoto Protocol on CO$_2$ production and consumption inventories, they do not empirically test the Kuznets curve hypothesis.

4 We follow Frankel and Rose (2005) and Aichele and Felbermayr (2012) in addressing endogeneity of carbon emissions with income and with the ratification of the Kyoto Protocol.

5 To the best of our knowledge, this is the first study that uses the threshold regression framework developed by Caner and Hansen (2004) for a panel setup in order to assess the existence of environmental gains from development in the form of a decrease in the income-elasticity of carbon emissions.

6 For theoretical work where an EKC-type income elasticity was modulated using the disutility from pollution, see e.g. Andreoni and Levinson (2001), Selden and Song (1995) and Stockey (1998); for constant or increasing returns to scale of abatement investment, see for example Andreoni and Levinson (2001) and Egli and Steger (2007), while Ordás-Criado et al. (2011) defined the mechanism through the propensity to spend in abatement endogenously determined by utility maximisation, for intergenerational externalities, see for example John and Pecchenino (1994), John et al. (1995), and Lieb (2004). See Dinda (2004), Pasten and Figueroa (2012), or Stern (2015), for more comprehensive reviews covering both theoretical and empirical literature.
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